How to Make Extra Money

# FIXING RADIOS

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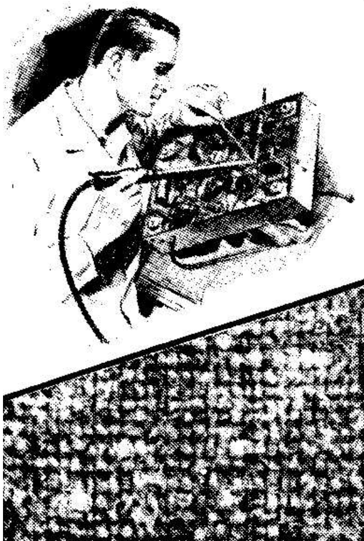

## No. 21

### How To Fix a Dead Receiver

## RADIO SERVICING METHODS

# NRI TRAINING *Pays...*

Dear Mr. Smith:

I doubt if you have ever had a student who was more doubtful about your Course than I. Before enrolling, I wrote to several graduates to ask them about the Course. They all answered that you could swear by it, and no truer words were ever written. The Course paid for itself long before I finished, and frankly I say it is worth ten times what it cost. The extra money I have earned has certainly been a great help.

W. B., Ohio



**NATIONAL RADIO INSTITUTE**
**WASHINGTON, D. C.**

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# HOW TO FIX A *DEAD RECEIVER*

ONE of the most common servicing jobs is fixing a dead receiver—one that does not play at all. To a radio mechanic, such a job is baffling. Almost anything can prevent a receiver from playing, and he may have to spend hours testing parts before he finds the defect. The professional serviceman, however, considers a dead set the easiest to repair, because his test procedures quickly and definitely locate the defective section and stage. Then a few simple tests are all he needs to locate the defective part.

As you know, a professional serviceman uses two powerful tools: 1, effect-to-cause reasoning; and 2, the six-step localization plan. As you learn to service like the professional, you will find that you can use effect-to-cause reasoning at any time—before making any tests, along with tests, or after having completed certain tests. Reasoning is important as a means of short-cutting steps in the already short series in the localization plan. However, if there are no clues leading to reasoning, you can follow the localization steps in order, with the assurance that you will be led to the defect in a quick, logical manner, no matter what it is.

You will seldom find it necessary to use the *complete* isolation procedures we will present here and in succeeding Booklets. Very often you will be able to skip steps, especially as you become more experienced and learn how to use effect-to-cause reasoning. However, we want you to learn all there is to know about isolation procedures now, for not until you know all about them will

| DEFECT LOCALIZATION | |
|---|---|
| 1. Confirm the complaint. | 4. Locate defective *stage.* |
| 2. Look for surface defects. | 5. Locate defective *circuit.* |
| 3. Locate defective *section.* | 6. Locate defective *part.* |

you be able to choose the procedures that will be best in any particular servicing job.

Now let's learn how to isolate the defective section, stage, circuit, and part in a dead set.

## THE FIRST TWO STEPS

You have already learned how to confirm the complaint and check for surface defects, but we'll review these first two steps of the general servicing procedure briefly. To confirm the complaint, simply turn on the receiver, and tune it to see if any stations are picked up; if not, the set is dead. Then look the chassis over for surface defects. Since the set is dead, look particularly for tubes that do not light, broken antenna and ground connections, an unplugged speaker, and flaring up of the rectifier tube. Be sure that tube top caps are in place and are not shorting to shields. Look for grid leads on the outside of tube shields when they should be on the inside. Check the position of the wave band switch (and phono switch if used). Notice whether the tuning pointer moves along the dial as you tune the receiver. A careful examination of the set may lead you directly to the cause of the trouble. If not, proceed to the next step.

## EFFECT-TO-CAUSE REASONING

Without making any localization tests, it is frequently possible to locate the defective section (or at least to reduce the number of possibilities) while the chassis is in the cabinet. For example, you can learn a great deal by listening to the speaker and reasoning from what you hear.

► First, there may be *no hum or noise of any sort* from the loudspeaker when the receiver is turned on. Any such *absolute* silence indicates that the trouble is in the power supply, in the speaker, or in the plate circuit of the output tube. (Even if the output tube is the only one working, there will be at least a slight hum from the loudspeaker.)



Of course, if you can hear a slight hum, the output stage and the speaker are working, and the power supply of the output stage is O.K., so you can proceed to other tests.

► Wiggle the volume control knob rapidly back and forth. This produces a certain amount of noise. Since the volume control is generally located at the input of the audio amplifier, the audio amplifier must be working if you hear any noise. (However, the amplifier is not necessarily defective if no noise is heard.)

► If the receiver is alive from the first detector to the speaker, you will *usually* hear a hissing or frying noise along with the hum when the volume control is turned up high. This hiss is the normal converter noise produced in the first detector tube. Its presence indicates that everything past the first detector is working, so the defect must be in the input of the receiver or in the oscillator stage. Absence of hiss does not show where the defect is.

## LOCATING THE DEFECTIVE SECTION

***What the Tuning Eye Shows.*** Locating the defective section is usually easy if the set has a "tuning eye." To see why, let's review the action of this device.

The tuning eye is a vacuum tube with a fluorescent screen in one end. (The screen end protrudes through the front of the receiver panel and gives a visual indication of the accuracy of the tuning.) Any part of this fluorescent substance that is struck by electrons glows a bright green color; parts not struck remain dark—almost black. How much of the screen is hit by electrons depends on the d.c. voltage applied to the control grid of the tube. This control voltage is the filtered a.v.c. voltage obtained from the second detector circuit, and its value depends on the strength of the signal at this point.

With no signal at the second detector, the eye appears as in Fig. *1A*. A large section of the screen is dark. The dark area decreases when a signal reaches the second

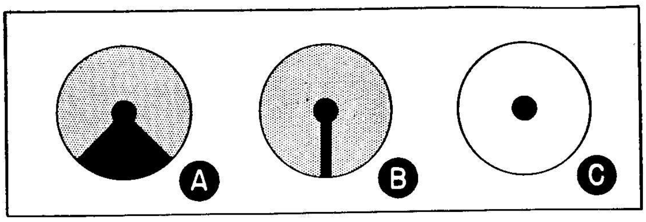



FIG. 1. The shadow of a tuning-eye tube is broad (A) when no signal is applied, and becomes narrower (B) when a signal is fed to the grid. If d.c. plate voltage is not applied to it, the eye does not become green (C) and no shadow appears.

detector, becoming smaller as the strength of the signal becomes greater. When a strong local station is tuned in accurately, the eye "closes" to the thin line shown in Fig. *1B*. Weak and distant stations close the eye only slightly.

Thus, the eye "samples" the signal at the output of the second detector stage. It also samples the output of the power supply, since the tube depends on the power supply for its plate and filament voltages.

Now, let's see what the eye, plus effect-to-cause reasoning, can tell us about a dead set.

***Case No. 1. Eye Does Not Turn Green.*** If the eye does not have its characteristic green color, but a *faint reddish glow* from its heated cathode is observed, you know that d.c. plate voltage is *not* being applied to the eye. Hence, the power supply is probably defective. (If the eye glows *bright pink* instead of faint red, and a dim shadow is seen, the tube may be gassy. It will have to be replaced before it can be depended on as an indicator.)

***Case No. 2. Eye Closes Normally.*** If the eye closes as it should when you tune the receiver to a station, but no signals are heard, the trouble is in the audio section of the set. The fact that the eye works means that the power supply is all right, and that normal signals are reaching the second detector—only the audio section is left as a possible source of trouble.

***Case No. 3. Eye Does Not Close.*** If the eye becomes green, but does not close up as you tune past stations (and no sounds are heard), the defect is in the r.f.-i.f.



section; r.f. signals are not reaching the second detector.

***Other Indicators.*** A meter-type tuning indicator does not show quite as much. If it works properly (the meter hand swings as stations are tuned), then the defect must be in the audio amplifier. However, if it fails to work, you must make other tests to determine whether the trouble is in the r.f.-i.f. section or in the power supply.

If the set is a phono-radio combination, try the phonograph. The phonograph connects to the input of the audio amplifier, so, if it works, the audio and power supply sections are good, and the trouble must be in the r.f.-i.f. section. However, if it fails to work, then other tests are needed to show whether the audio section or the power supply section is at fault. (Be sure that the phono-radio switch is properly set to the phono position, and that the volume control is turned to the maximum volume position when you try the phonograph.)

From the foregoing, you can see that reasoning, coupled with a few clues and tests, may tell you the section of the receiver in which the trouble lies, and perhaps even the stage in that section. If these steps fail, then you must go on to other methods of localization. Since these methods will all localize the defective stage as well as the section, these two steps are frequently combined.

## LOCATING THE DEFECTIVE STAGE

The best method of stage localization to use for a dead set depends on the equipment available, and on the kind of radio. For example, a signal tracer can be used on any radio, so signal tracing is a universal method of locating the defective stage. If the set is a.c. operated, then one form of circuit disturbance can be used; another form must be used on a.c.-d.c. receivers. On some sets, one method may be better or faster than another, but the opposite may be true on other receivers. To show all the methods, let's first suppose that you are servicing a broadcast-band a.c.-operated superheterodyne of the type shown in Fig. *2*. (You will study the superheterodyne in detail in your Course, so, if the

operating descriptions seem vague now, remember you will learn more about them.)

***Circuit Disturbance Procedures.*** A circuit disturbance test, as you know, is made by disturbing the circuit in some manner (say by pulling out a tube or by touching or pulling off a grid cap). This creates the electrical equivalent of a noise in the set. If the receiver is all right between the speaker and the point where the disturbance is created, the disturbance will travel through the set and create a click or buzz in the speaker. (The methods of creating a circuit disturbance were covered in an earlier RSM Booklet.)

To prepare the set for your tests, proceed as follows: 1, be sure the set is turned ON; 2, turn the volume control to maximum volume; 3, set the wave band switch (if any) to the broadcast position; 4, set the phono-radio switch (if any) to the radio position. The set is now ready for tests.

► Always begin your tests at the first audio tube; this serves at once to localize the defective *section.* In the set shown in Fig. *2,* the triode section of the 6Q7 is the first audio tube. If a click or buzz is heard when you disturb it, then the audio and power supply sections are O.K.—the trouble is in the r.f.-i.f. section. In this case, disturb the i.f. tube. A click means everything is normal in the i.f. and second detector stages.

If no click is heard when the i.f. stage is disturbed, you won't know whether it is the i.f. stage or the second-detector stage that is at fault. You should make a tube test, and then proceed to *circuit* localization tests; these will be explained later.

### CIRCUIT DISTURBANCE TABLE

1. TOUCH TOP CAP OF FIRST AUDIO TUBE.
2. BREAK AND MAKE THE GRID CONNECTION BY PULLING OFF AND REPLACING THE GRID CLIP.
3. PULL OUT AND REPLACE THE TUBE.

**Method *2* is the easiest to use when the tube has a top cap, and can be used on a.c., battery, or a.c.-d.c. sets.**
**Method *3* is necessary for single-ended tubes, but can be used ONLY on auto sets or on a.c. sets operating from a power transformer.**



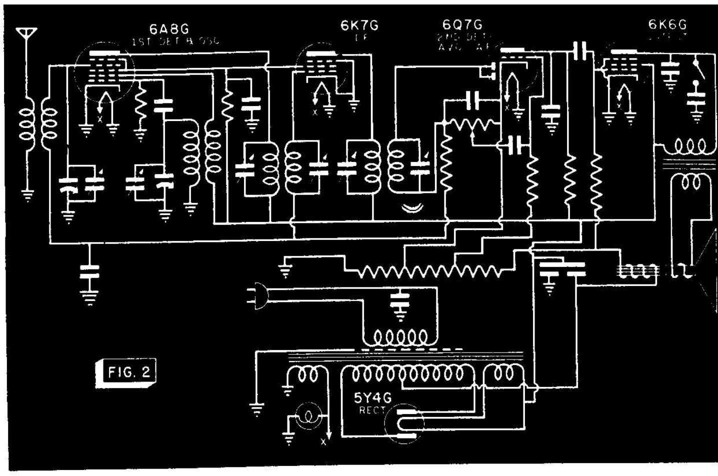


FIG. 2

Of course, if the i.f. stage disturbance is heard, the 6A8 first-detector and oscillator is left as the logical suspect. If disturbing this tube produces a sound from the loudspeaker, then either the oscillator has stopped working, or there is trouble in the input circuit. No sound indicates a tube defect, a plate or screen grid trouble, or a defect in the i.f. transformer.

► Going back to the test on the 6Q7 tube—naturally, if there is no click, you will have to localize the trouble in the audio and power sections. You can pull out the 6K6 power output tube (it has no top cap) and listen for a click. (However, don't pull out the power output tube if you can avoid it. This tube draws considerable current. When it is pulled out, the d.c. drop in the power supply is reduced; this may let the supply voltage rise enough to damage a filter or a by-pass condenser.)

No click when the 6K6 tube is pulled out indicates: 1, a power supply defect; 2, a defect in the speaker; 3, a defective output transformer; or 4, a defective 6K6 tube. On the other hand, a strong click from this tube but none from the 6Q7 tube shows that the trouble is in the 6Q7 triode stage or in its coupling to the 6K6 grid circuit. (An open coupling condenser is a logical suspect if the 6Q7 tube is good.)

***Circuit Disturbance with a Voltmeter.*** Unfortunately, the foregoing simple tests cannot be used on an a.c.-d.c. set like the one in Fig. *3.* (Since you will refer to it

several times in this Booklet, Fig. *3* has been placed on pages 10 and 11 for convenience.) The tubes in this set have no grid caps and cannot be pulled out (since their filaments are in series), so some other method of disturbing the circuit must be used.

One handy way of doing this is to measure voltages in the set with a voltmeter. Since the meter draws current, it disturbs the circuit enough to permit location of the defective section and stage; at the same time, the meter indication can often be used to locate the defective circuit or part directly. We will describe the complete test procedure for the a.c.-d.c. set shown in Fig. *3*. The same general method can also be used to test a straight a.c. receiver if you wish.

First, take the receiver out of its cabinet. Be sure the speaker is plugged in, then turn on the receiver and turn up the volume control completely. If it is a multi-band set or a phono-radio combination, see that the switches are set for standard broadcast reception.

► Next, turn the set upside down and touch your finger to the grid terminal of the 12SQ7 tube (or to the center terminal of the volume control). Either disturbance should cause a buzz in the speaker. (If it is not safe to put your finger in, use a test lead. Touch the probe to the terminal while holding the other end of the test lead in your hand.) If the disturbance comes through, the audio section and its power supply are O.K.; the trouble is in the r.f. section. However, if the disturbance does not come through, the trouble is in the audio section.

► Let's first assume that the disturbance does *not* come through the loudspeaker (the trouble is in the audio or power sections). To check the power supply, measure the voltage applied to the *screen grid* of the 50L6 power output tube. Place the positive voltmeter probe on the screen terminal, and the negative probe on B— (in this case the receiver chassis). If voltage is obtained, the power supply is O.K., so proceed to test the audio section as follows:

Move the positive probe of the meter to the plate of the output tube. *At the moment the probe touches,* the meter starts drawing current through the output trans-



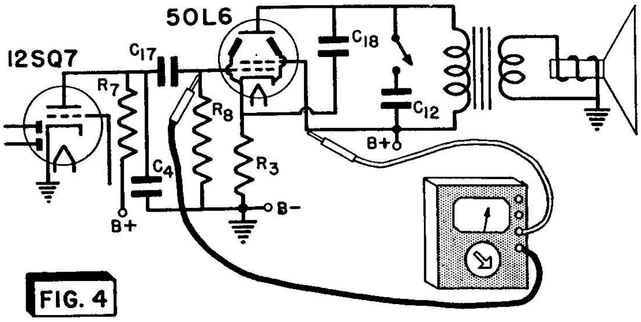



FIG. 4

former. Also, when the meter probe is removed, the circuit current goes back to that drawn by the tube. These momentary *changes* in the current cause a.c. pulses through the transformer, so you should *hear a click from the speaker* and should find voltage. If there is *no click,* suspect a defect in the output transformer or an open in the speaker voice coil. ( A meter having a sensitivity greater than 5000 ohms-per-volt may not draw enough current to cause a click in this test, but a less sensitive meter should. Any meter will be all right for most of the tests to be described next.) Lack of *voltage* indicates an open in the primary of the output transformer or a short in plate-to-cathode by-pass condenser $C_{18}$.

If the click is heard and voltage is found, move your positive voltmeter probe to the plate of the 12SQ7. (Keep the negative probe on the chassis for all screen and plate voltage tests.) You should find voltage and hear a click as you make or break contact. If there is *no voltage,* $R_7$ may be open, or $C_4$ may be shorted. If you find *normal voltage but hear no click,* the trouble is between this point and the plate of the 50L6 tube (since a click was heard when the 50L6 plate voltage was measured). In this latter case, the next thing to do is to disturb the control grid circuit of the 50L6 tube. To do so, put the negative voltmeter probe on the grid socket terminal of the tube, and momentarily tap the positive probe on B+ (the screen of the 50L6 will do). As shown in Fig. *4*, the meter will allow current to flow through $R_8$, producing a voltage across it. This will cause the

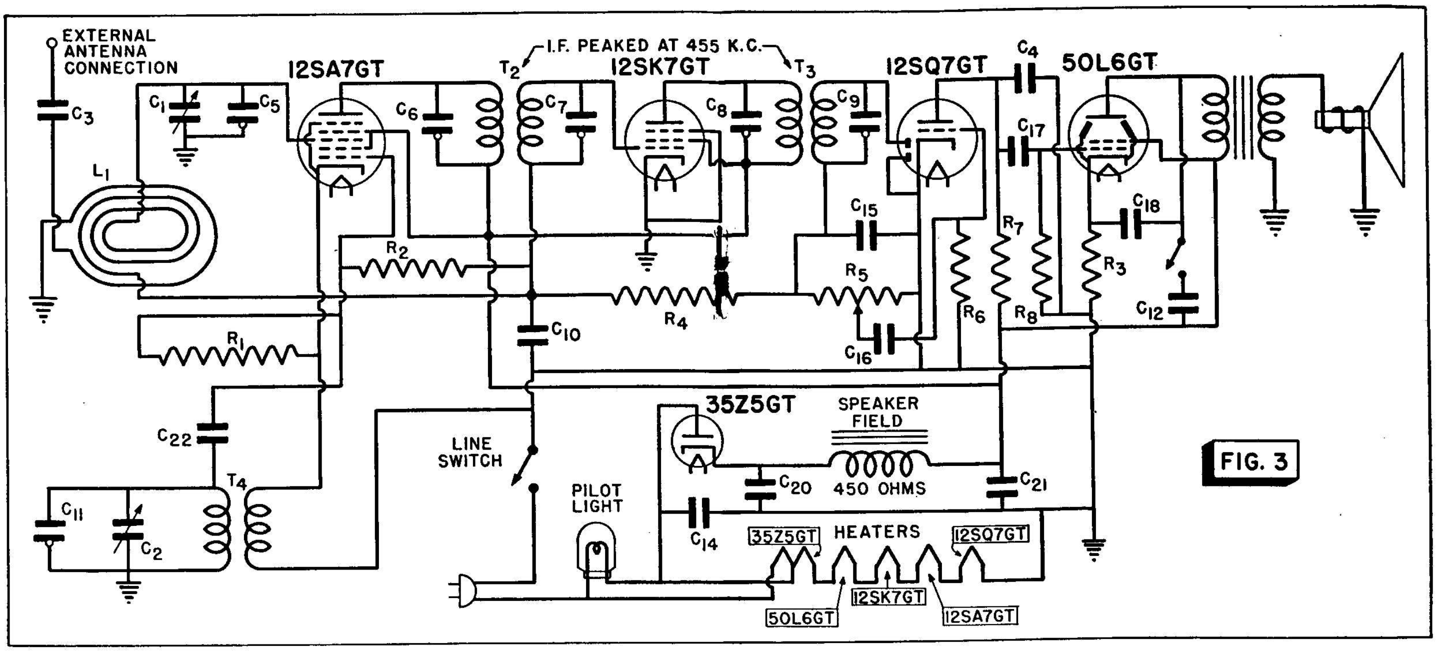



FIG. 3

plate current of the tube to change, and should make a click in the speaker.

Notice that since the negative voltmeter probe connects to the grid side of $C_{17}$, this click signal does not go through $C_{17}$. If you hear the click on the grid side of $C_{17}$ but did not when you checked the plate circuit of the 12SQ7 tube, you may be certain that $C_{17}$ is open and is the cause of the trouble.

On the other hand, if you do not get a click at the grid of the 50L6, the trouble must be between the grid and plate circuit of this tube. Almost certainly the 50L6 is defective, or $R_3$ is open.

► Assuming your original test shows that the audio and power supply sections are all right (that is, you hear a buzz when you touch the 12SQ7 grid), use the voltmeter to check in the r.f.-i.f. section. Using Fig. *3* as our example again, touch the positive voltmeter probe to the plate of the 12SK7 i.f. tube, and the negative probe to the chassis. You should find plate voltage and hear a click signal. No voltage indicates an open primary in $T_3$. If you find voltage but fail to get a click, the trouble is between this point and the volume control $R_5$. Transformer $T_3$ may have an open or shorted secondary, $C_9$ may be shorted, or the diode section of the 12SQ7 may be defective.

If you get a click, introduce a grid-voltage change in the 12SK7 by placing the negative voltmeter probe on the control grid socket terminal and momentarily touching the positive probe to some point in the B+ circuit, as shown in Fig. *5*. (You can use the screen of the 50L6 or the screen of the 12SK7, since both connect to B+.) If the 12SK7 tube is good, you will hear a click. A voltage reading shows there is continuity from the grid to B—, but is otherwise meaningless.

Next, move the positive voltmeter probe to the plate of the 12SA7 mixer, and touch the negative probe to the chassis (B—). You should find plate voltage and hear another click. No plate voltage reading indicates

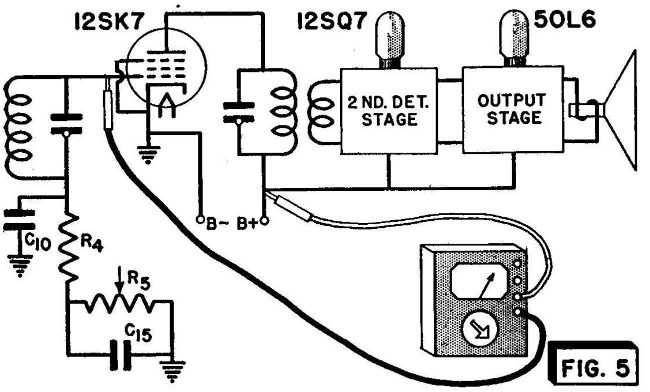


FIG. 5

an open in the $T_2$ primary. However, a voltage reading but no click might mean that condenser $C_{10}$ is open, that $C_6$ or $C_7$ is short-circuited, or that $C_6$, $C_7$, $C_8$, and $C_9$ are incorrectly adjusted. (Methods of adjusting these and other condensers in tuned circuits are taken up in another RSM Booklet.)

If you get a click signal through from the plate of the 12SA7, introduce a grid-circuit pulse by placing the negative voltmeter probe on the control grid, and momentarily touching B+ with the positive probe. The voltage measured here shows only that the grid circuit is not open, but the click produced should travel through to the loudspeaker. If you don't hear a click, the tube may be at fault. However, if you hear a click (and the receiver is still dead), the oscillator may not be working.

Oscillator failure may be caused by a bad 12SA7 tube, a change in value of $R_1$, a short in oscillator condenser $C_2$, or a defect in $T_4$ (the oscillator coil assembly). Try shorting the rotor and stator of $C_2$ with a screwdriver; if you hear a click, the oscillator is probably working, so the trouble is in the loop antenna or in the tuned circuit adjustments. (More definite methods of checking for life in local oscillators are taken up elsewhere.)

► Notice—although this voltmeter disturbance test is basically a way to find the defective stage, very often the tests may show the defective circuit and part as well. It may have appeared a little complicated at the first reading, but if you go back over it you will quickly



see that there are only two main steps in it. First you measure the plate voltage of a tube, then you feed a signal into its grid. This procedure is followed for each tube in the defective section, starting with the tube nearest the speaker. As long as you hear a click, the stages, circuits, and parts between your point of measurement and the speaker must be all right. When you no longer hear a click, the voltage reading, or lack of it, may show you the defective circuit or part at once.

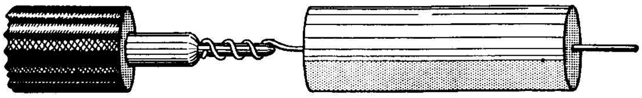
Now let's study still another method of localizing the defective stage.

***Localization with a Signal Generator.*** The signal generator is particularly useful for tracing through the r.f. stages—it is not as handy for the audio section as are other methods. For this reason, most servicemen touch the grid of the first audio tube to determine whether the trouble is in the audio or power supply sections. If so, they proceed to the voltmeter or other disturbance methods.

However, if the above test shows the audio section and power supply are in working order, then the signal generator may be used to check the r.f. section.

To use this method, you must know your signal generator—how to change its frequency band, how to adjust it to the desired frequency, and how to control its output. Set its controls so that its output is modulated in order to provide an audible signal. Determine whether it has a condenser in series with its output, to block the flow of direct current; if not, insert a condenser (any capacity from, say, .002 mfd. to .006 mfd.) in series with the "hot" (ungrounded) lead.

► The signal generator can be used to test any receiver. For a specific example, let's take the a.c.-d.c. receiver shown in Fig. *3*. Prepare the receiver for testing in the manner described earlier for the voltmeter tests. Be sure to turn it on. For the first test, connect the signal generator (s.g.) ground lead to the chassis of the receiver, and connect the other s.g. lead or probe (known as the free or hot probe) to the plate socket terminal of the i.f. tube. This injects a signal into the primary of the second i.f. transformer (see Fig. *3*), whence it is



**The easiest way to put a condenser in series with the hot lead of an s.g. is to wrap one lead of the condenser around the probe as shown, then use the other condenser lead as the probe.**

induced in the secondary of the transformer and is applied to the second detector. Set the s.g. to the i.f. value of the receiver (456 or 465 kc. in most modern a.m. receivers), and advance the attenuator (volume control) of the s.g. to maximum output. If no tone is heard, transformer $T_3$ or the diode section of the 12SQ7 tube is defective. (Condenser $C_8$ or $C_9$ may be shorted.) If the tone *is* heard from the loudspeaker when the s.g. is connected to the plate of the i.f. tube, the second detector and the audio section are good. Next, move the hot probe of the signal generator from the plate of the i.f. tube tc its top cap (if it has one) or to the plate of the preceding tube. (This is the first detector in Fig. *3*. However, in many sets there are two i.f. stages, so you would move back to the first i.f. stage in these sets.) The signal from the loudspeaker should remain the same volume as before, or become louder. If it *disappears* or becomes *considerably weaker*, the i.f. stage is defective. Test the tube and check the voltages applied to its electrodes, particularly the screen-grid voltage.

If the i.f. stage is all right, check the mixer (first detector) stage. First, tune the receiver to the low-frequency end of the dial to reduce the shorting effect of the tuned input circuit on the signal. Then, with the signal generator still tuned to the i.f. value, move the hot probe to the grid of the mixer tube. If the signal disappears or is *greatly* reduced in strength, the mixer stage is at fault. Check the tube and its voltages.

If the signal can be heard, the mixer stage is at least capable of amplifying. In this case, check the frequency conversion and the local oscillator. To do so, change the signal generator to some frequency in the broadcast band, and tune the receiver to the same frequency. If the local oscillator in the receiver is working properly, the signal generator signal (still applied at the input



of the mixer tube) and the local oscillator signal will combine to produce an i.f. signal, and the modulation tone will be heard in the loudspeaker. If you hear no tone, probably the oscillator is dead. (The mixer may not be acting as a detector tube, but this is unlikely if the preceding test was normal.)

You can make an additional check for a defective oscillator by tuning the receiver to the frequency of a local station, then tuning the s.g. (connected to the input of the mixer) to a frequency that is above or below the local station frequency by the i.f. value of the receiver. For example, if the receiver is tuned to a 1200-kc. station, and the i.f. value is 465 kc., set the s.g. either to 1665 kc. or 735 kc. If you hear the program of the local station mixed with the s.g. tone, you know that the local oscillator is defective.

If these tests show that the local oscillator is functioning, set the s.g. to the same frequency as the receiver, then touch the free s.g. probe to the antenna terminal of the receiver. Since everything else has been normal to here, the tone in the loudspeaker should stop at this point. Failure of the signal to come through at the antenna post is most likely due to an open in the primary of the antenna coil.

## SIGNAL TRACING

A signal tracer can be used to follow the signal from the input of the set to determine where it is interrupted. The signal tracer method is perhaps not quite as fast as some of the others if the defect is a common one, but it is much faster when some unusual trouble exists. Let's see how to use it. We'll assume you have a tracer that uses a meter or magic-eye indicator, and also has a loudspeaker so that you can hear its output. Also, we'll use the circuit shown in Fig. *3* as an example again.

The input signal may be either that of a local broadcast station or the modulated output of an s.g. Turn on the receiver and tune it to the point where this signal would be received if the set were working, then connect the ground clip of the signal tracer to the set chassis

or ground terminal. You can now use the hot probe to trace the signal.

As you become expert in the use of a signal tracer, you will probably eliminate as much testing as possible by making rather large jumps in following the signal—jumping from grid to grid, say, or even from section to section. At the beginning, however, it is best to trace the signal at each grid and plate circuit.

In this example, start with the hot probe on the control grid of the 12SA7 tube. Tune the signal tracer to the frequency of the incoming signal, and retune the set, if necessary, to give maximum indication on the signal tracer. If the signal is picked up at the grid of the 12SA7 tube, the input circuits of the receiver are in good condition.

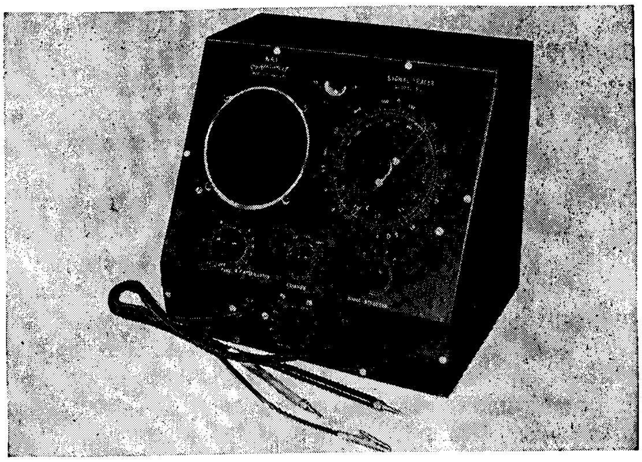
Next, move the hot probe to the plate of the 12SA7 tube, and tune the signal tracer to the i.f. frequency of the set. No signal here may mean that there is no B supply voltage, that at least one section of the 12SA7 tube is not working, that $C_6$ is short-circuited, that the primary of i.f. transformer $T_2$ is short-circuited, or that the oscillator is misaligned.

You can check the oscillator with the signal tracer by applying the hot probe to the first grid of the 12SA7 tube. Tune the signal tracer over its band and see if you can pick up the oscillator signal. If not, then there is trouble in the oscillator circuit. If you do pick it up, notice the frequency at which you find it on the signal tracer dial. This frequency should be equal to the incoming signal frequency plus the i.f. frequency of the set. If it is far different from this, then the trouble may be that the oscillator circuit is out of alignment.

Assuming that you hear a signal at the i.f. frequency at the plate of the 12SA7 tube, you can now move to the grid of the 12SK7 tube. Lack of a signal here indicates trouble in transformer $T_2$ or in its trimmers $C_6$ and $C_7$.

If you find the signal at the grid of the 12SK7 tube, move back to its plate. The signal tracer must still be tuned to the i.f. frequency. Lack of a signal here indicates a defective 12SK7 tube, improper operating voltages, or trouble in the primary of $T_3$ or condenser $C_8$.





**A signal tracer, such as this NRI Professional Model 33, speeds up the trouble localization in a dead receiver whenever you encounter an unusual defect. However, if you have no tracer, the other methods described will be reasonably speedy.**

Next, move back to the diode detector of the 12SQ7 tube, leaving the tracer tuned to the i.f. frequency. No signal probably indicates an open in the secondary of $T_3$, or a short in $C_9$. If you find the signal, change to the audio tracing probe of the signal tracer and apply it to the grid of the 12SQ7 tube. No signal here probably means an open in $C_{16}$ or a short in $C_{15}$. There is also the possibility that the volume control is defective.

If you find the signal at the grid of the 12SQ7 tube, move back to its plate. Lack of signal here indicates a short in $C_4$, an open in $R_7$, or a defective 12SQ7 tube.

You can then move to the grid of the 50L6 tube. If you find no signal here, but did get a signal at the plate of the 12SQ7, then coupling condenser $C_{17}$ must be open.

Finally, if you find a signal at the 50L6 grid, move the probe to the plate of the 50L6 tube. No signal here means a defective 50L6 tube, an open primary of the output transformer, or a short-circuited condenser $C_{18}$.

► As you can see, the signal tracer is used by moving successively from grid circuit to plate circuit throughout the receiver until you find the point at which you hear no signal. At that point, you can stop and resort

to your ohmmeter and voltmeter to find the defect. The signal tracer has the advantage of finding not only the defective stage but also the defective circuit.

► As we mentioned earlier, it is a waste of time to check and follow the signal through the entire receiver just to find that the trouble is at the output stage. For this reason, most servicemen first make some circuit disturbance test or otherwise assure themselves that the audio amplifier is working and that the power supply is normal, before using the signal tracer. Therefore, you will find the signal tracer will be of greatest use in locating troubles in the i.f.-r.f. section of the receiver.

***Locating the Defective Part.*** Regardless of the section and stage localization procedure you follow, your job is incomplete until the defective part is found. Reasoning may point to the part once the trouble has been partially localized, but, if not, your voltmeter and ohmmeter can be used to find the open or short circuit that causes the set to be dead. Follow the test procedures you have studied in other RSM Booklets to find the defective circuit and part.

The signal tracer (and the voltmeter disturbance test) will indicate directly an open coupling condenser. This is important to remember—an open coupling condenser will not upset any circuit voltage nor will it affect the continuity. If you are using other methods of localization, always remember to suspect an open coupling condenser if you have localized the trouble to a stage using one, and can find nothing else wrong.

### NRI PRACTICAL TRAINING PLAN

You have now reached a point where you can introduce a number of defects into the receiver you are using

**BENCH HINTS**

The easiest way to remove a hollow rivet is to drill it out with a hand drill. Sometimes, however, the rivet will begin to turn with the drill after you have gotten started. If this happens, place a chisel across the peened (bent-over) end of the rivet and strike it two or three times with a hammer. This will usually jam the rivet in place firmly enough for you to be able to drill it out.



for experiments. If you have not yet obtained this receiver, get one as soon as possible, and go back over all the steps given in earlier RSM Booklets. Then carry out the following steps in order.

***Step 1.*** *Check Performance of Receiver.* Tune in local and distant stations at different points on the tuning dial while the set is connected to a good outdoor antenna, so you become familiar with the sensitivity and selectivity characteristics of the receiver. Become familiar with the receiver controls—try them all.

***Step 2.*** *Make a Circuit Disturbance Test.* With the receiver in operation, carry out the circuit disturbance test as used for locating the defective stage in a dead receiver. Do this first by pulling out and replacing each tube in turn while the receiver is tuned between stations. (Work from the loudspeaker back toward the input in these tests.) Next, touch the control grid terminal of each tube in turn with your finger. Make the test once more, this time removing and replacing each top cap connection. Notice that sometimes you get clear-cut clicks, sometimes there is a squeal. Repeat the procedure, using your voltmeter.

***Step 3.*** *Make a Defective Stage Isolation Test with a Signal Generator.* With the receiver operating but the aerial disconnected, make a defective stage isolation test with your signal generator, just as you would for a dead receiver.

***Step 4.*** *Follow the Signal.* If you have a signal tracer, practice following a signal from the input toward the output.

***Step 5.*** *Create a Dead Receiver.* Study your receiver diagram to see what defects could cause your receiver to be dead. Then study the list in the table given on page 21 of this RSM Booklet. All the troubles EXCEPT those given with a star (*) may be safely introduced into the receiver. WARNING: Those marked with a star (*) may cause damage to other parts, so don't try them. Create these defects, one at a time (instructions are given below); then use all the methods of localization that you have learned, to find the trouble. When you have localized it in each case, restore the receiver

to normal and introduce another defect.

► To simulate a burned-out tube filament, unsolder one of the filament power leads at the socket. (Should there be two wires, leave them fastened together—disconnect both from the socket terminal—so that you will be interrupting only one filament supply at a time.)

► You can simulate an open resistor or condenser by unsoldering one terminal from the circuit wiring. Be sure the wires you unsolder cannot touch the chassis or another terminal. If necessary, use tape over the free wire ends.

WARNING: If you unsolder the cathode bias resistor for the output tube, be sure to disconnect also its by-pass condenser to avoid damage to this condenser.

Not *all* open resistors or open condensers will make the set dead. It is a good idea to unsolder a number of each to see just what effect is produced.

► Unfortunately, short circuits cannot be readily introduced into supply circuits, as resistors or other parts may be damaged. However, you will get experience with these cases when you begin to service radio receivers.





## DEFECTS COMMONLY CAUSING A DEAD RECEIVER

| *Cause* | *How to Test* | *Usual Location* |
|---|---|---|
| Burned out tube filament | Ohmmeter or tube tester | Any stage |
| Loss of emission in tube | Tube tester or substitute good tube | Any stage |
| Open resistor | Ohmmeter | Screen and plate circuits |
| Shorted by-pass* condenser | Ohmmeter | Any screen or plate circuit |
| Broken connection | Ohmmeter or visual inspection | Any stage |
| Tube not firmly in socket | Push down on tube | Any stage |
| Top cap connector off tube | Visual inspection | Any section |
| Top cap shorting to tube shield | Visual inspection and wiggle grid lead | Any section |
| Shorted electrolytic* condenser | Ohmmeter | Power supply |
| Open electrolytic condenser | Shunt suspect with another condenser | Input filter in power supply |
| Open field coil | Hold screwdriver to field to note magnetic pull | Loudspeaker (power supply) |
| Open line cord | Ohmmeter | Power supply |
| Burned out a.f. transformer primary | Ohmmeter | Audio section |
| Loudspeaker* unplugged | Visual inspection | Audio section |
| Open coupling condensers | Shunt suspect with another condenser | Audio section |
| Open voice coil | Visual inspection or ohmmeter | Loudspeaker (audio section) |
| Phono-radio switch | Turn switch to other position | a.f. section |
| Open r.f., i.f., or oscillator coil | Ohmmeter | r.f. section (usually a plate winding) |
| Tuning condensers shorted | Scraping sound when tuning | r.f. section |